PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Process and apparatus for Producing Sheets of Thermoplastic Material

I, BENT HOJBERG PEDERSEN, of 15, Norske Alle, Holte, Denmark, a Danish Subject, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed to be particularly described in and by the following statement:—

One method of producing thermoplastic sheet material comprises winding an extruded filament or band on to a rotating drum or the like so as to form a tube, the juxtaposed convolutions being caused to adhere to one another and then cutting the tube from end to end and opening it out into a sheet.

In this known method the synthetic filament or band is wound on to a drum or cylinder the length and circumference of which corresponds with the size of the sheet.

Usually, the synthetic filament is wound on over the whole length of the drum and while the tube thus formed is still on the drum, the tube is cut from end to end and removed from the drum. This method is quite complicated, because the various operations must be interrupted each time that a tube has been formed with a length which is at the most the same as the length of the drum. Also, the method makes relatively heavy demands on the machinery employed, more particularly if the tubes formed during the winding-on operation are to be relatively long, for in such case it will generally be necessary for the source whence the synthetic filament is guided on to the rotating drum to be displaced lengthwise thereof as winding-on progresses.

It will be seen therefore that the known process is necessarily intermittent, and the present invention is designed to provide a continuous process for the production of sheets from filaments or bands, and apparatus for carrying the process into effect.

According to the invention, for the production of sheets of thermoplastic material, a filament or band of thermoplastic material is wound on to a rotating member or former, the juxtaposed convolutions are caused to adhere to one another and the tube so formed is progressively displaced axially relatively to the rotating former, the tube being finally cut axially and opened out into sheet form. The axial displacement of the tube progresses at the same rate as the length of the tube is increased during the winding-on operation. Consequently, with this process it is possible to produce a tube of indefinite length, and from which shorter tubes of a desired length can be cut and then opened out to form sheets after being cut from end to end. Alternatively, the tube can be cut along one side and opened out as it is being displaced axially, so as to produce a sheet having a width equal to the circumference of the rotating member or former, of indefinite length. It will be appreciated that the rotating former may comprise a drum which is relatively short axially, and consequently will be relatively light in weight as compared with the rotating drum required for the known process referred to above.

Another advantage of this method is that the filament or band is always fed to the rotating former at the same region axially relatively to the rotating former, and this feature permits the use of simple filament or band feeding apparatus.

Apparatus for carrying out the method according to the invention comprises a short drum which is rotatably mounted and has one end free and a fixed stop or abutment disposed adjacent to the other end of the drum or former, means for feeding a filament or band to the drum or former so as to engage with the fixed stop, and means for causing the juxtaposed convolutions wound on to the drum or former to adhere to one another to form a tube, and means for axially cutting the latter to produce a sheet.

In one embodiment of the process according to the invention, the end of the filament employed is releasably secured to the winding member or former at some axial distance from the stop or abutment, and a number of turns are wound on until the

[*Price 3s. 6d.*]

filament approaches the stop member, whereafter the subsequent turns are continuously stuck together during the winding-on operation, for instance, by spraying with acetone or other solvent, or an adhesive substance. Alternatively adhesion may be effected by heating the filaments. Preferably, the winding member will decrease slightly in diameter in the direction away from the stop member in order that the resistance to displacement of the tube formed during winding-on may not be excessive, and the first turns to be produced will therefore generally be smaller in diameter than the turns wound on to the winding member directly after the stop member.

The synthetic filament to be wound on can be supplied from supply reels or directly from a spinneret or extrusion nozzle in which the filament is formed. More particularly in the latter case, the filament can be wound on satisfactorily without any interruptions and pieces of a suitable length can be cut subsequently from the tube produced. Preferably, however, according to tht invention the sticking operation is interrupted after a predetermined length of tube has been produced, whereafter a new length of tube is started without interruption of the filament. If sticking is produced by spraying acetone, such spraying can be interrupted at suitable intervals over a length of filament corresponding to one or more turns. In this way it is possible to produce *seriatim* an arbitrary number of tubular members which are of predetermined and possibly varying lengths, and which are connected to one another for the reason that the filament continues from one tubular member to a subseequent tubular member, although the tubular members can readily be separated from one another by severing the connecting filament.

The synthetic filament employed can be of any desired cross-section. Preferably, a lightweight tubular synthetic filament of circular cross-section will be used which, under the pressure applied during winding-on, can be brought to a substantially rectangular or possibly square shape in cross-section. A hollow filament of this kind can give the finished product considerable strength for a relatively lightweight. However, the same advantage can also be obtained with synthetic filaments of other cross-sectional shape. For instance, the filament may be substantially Z-shaped in cross-section and may be wound on in such manner that the two arms of the profile form the surface layers in the finished sheet, while the profile body forms internal strengthening ribs for the sheet.

The finished material in sheet or plate form can be used for widely differing purposes. For instance, it can be used for packing, as insulating sheets, insulating mats and for furniture. Also, the sheet material can be used for producing vacuum-shaped or heat-pressed articles such as, for instance, fluorescent light fittings. The strength and appearance of the sheet material can be varied according to the purpose for which it is required, more particularly by choosing a suitable thermoplastic starting material. If a transparent synthetic filament is used, the finished sheets can also be used as windows which, although not really transparent, will be translucent.

The invention also relates to an apparatus for carrying out the process hereinbefore described. The apparatus is distinguished in that it has a short drum which is rotatably mounted with one end free and a stop member disposed at or near the other end for engagement with the filament or band while the same is being wound on the drum so as to progressively displace the convolutions axially during the winding on. The stop member can, if required, be rigidly secured to the drum so as to rotate therewith, but in practice the stop member will preferably be stationary. The stop member may comprise a ring which surrounds the drum and engages with the drum surface with little friction. The filament engaging edge of the ring extends conveniently only over a part, preferably about half, of the periphery of the ring defining a helical path. If the said edge were formed as a helix around the complete periphery, the tube formed during the winding-on would constantly be displaced in its entirety along the winding drum. In such a case friction between the tube produced and the drum surface might become insufficient to entrain the filament reliably. This disadvantage is obviated if the axial displacement of the tube is at every instant effected only over a suitably small part of the tube periphery.

In order that the invention may be clearly understood and readily carried into effect, apparatus according to the invention will now be more particularly described, by way of example only, with reference to the accompanying drawings wherein:

Fig. 1 is a side elevation, partly in axial section, of a first embodiment of the apparatus.

Fig. 2 is a developed view of a ring which serves as a stop member and with which a number of filament turns are shown in engagement,

Fig. 3 is a diagrammatic plan view of a second embodiment of apparatus according to the invention,

Fig. 4 is a sectional view, taken along the line IV—IV of Fig. 3, through the stop member of the apparatus and through the cooperating part of the winding drum, and

Fig. 5 is a detail sectional view showing a cutting device carried by the winding drum.

Referring to Fig. 1 a relatively short, drum-like member 1 having a hub 2 is rotatably mounted on a bearing shaft 3. A groove 4 is formed in the left-hand end portion of the drum surface to receive a V-belt (not shown)

by means of which the drum can be rotated. A ring 5 is fitted around the drum immediately to the right of the groove 4, the ring 5 does not rotate with the drum but is guided thereon by means of a number of screws 6 or similar guide pins which engage in a groove 7 extending around the surface of the drum. The ring 5 may be held against rotation in any convenient manner, for example, a bracket 18 may be attached to the ring and be also secured to any convenient stationary member. To the right of the ring 5 the surface of the drum 1 has a slightly conical part 8 on which a loose ring 9 is fitted and is retained thereon by friction.

At the commencement of winding-on, the end of the filament is secured to the loose ring 9 by means of a resilient clip or clamp 10. When the drum is thereafter rotated, the filament is wound on to the drum 1 between the ring 9 and the ring 5 which serves as stop member, the right-hand lateral surface 11 of the ring 5 extends as shown in the developed view shown in Fig. 2. Over a section *a* which extends over substantially one-half of the periphery of the ring 5, the said lateral surface 11 is disposed in a plane perpendicular to the axis of the drum 1, whereas over a section *b* comprising the remainder of the periphery of the ring 5, the lateral surface 11 extends along a helical or spiral path. Such a path starts at 16 with an incision in the ring of the same depth as the thickness of the filament employed. When the filament is introduced into the said incision during the winding-on operation, the filament will, when it is drawn by the drum over the section *b*, clamp the turns 12 already wound on. The finished tube will therefore be displaced continuously axially on the section *b* but not on the section *a*. During this operation the ring 9 is forced off the drum, and a tube consisting of turns of filament is produced as hereinbefore described.

If required, the stop ring 5 can be adjustable circumferentially around the drum 1 so that the beginning of the section *b* can be disposed in suitable relationship to the place where the filament is fed to the drum 1.

In the embodiment illustrated in Figs. 3 and 4, the drum 1 may be constructed in substantially the same way as the drum shown in Fig. 1 but, as can be seen in Figs. 3 and 4, the stop ring 5 is replaced by a roller 13 rotatable upon a spindle 14 extending radially above the drum 1. By way of a nozzle 15, acetone or other solvent or adhesive can be sprayed onto the filament 12 immediately before the filament reaches the drum 1. It will be understood that a similar nozzle may be provided for the arrangement shown in Fig. 1.

The winding of the filament 12 on to the drum 1 as shown in Figs. 3 and 4 can be initiated in the same way as explained with reference to Fig. 1. After a number of filament turns have been wound on to the drum, the filament enters into bearing relationship with the side of the roller 13 which can rotate freely on the spindle 14. The roller 13 has the same effect as the stop ring 5 shown in Fig. 1, causing progressive axial displacement of the filament turns along the drum 1.

The filament 12 is assumed to be initially tubular or circular in cross-section but, as shown in Fig. 4, the cross-sectional shape changes during winding-on to a substantially square shape. For this purpose, the stop roller 13 has a peripheral groove 17, the two sides of which are substantially perpendicular to one another. During winding-on, the roller 13 exerts a lateral thrust upon the filament 12 such that it substantially fills the groove 17 and assumes the cross-sectional shape of the groove.

By means of the apparatus described, a tube of any desired length can be produced in a continuous operation, and the tube produced can be subdivided during production into suitable tubular members if the spraying of solvent or adhesive through the nozzle 15 is stopped. If the adhesion of the filament is interrupted over a length greater than the drum periphery, the finished tube will break when it passes beyond the free end of the drum. The loose filament must then be cut to release the completed cylindrical member from the succeeding cylindrical member in process of being wound on the drum.

Striped tubes or sheets can be produced by winding two or more filaments of different colours and/or different degrees of transparency side by side on to the drum simultaneously. In such a case the incision 16 will be of a depth corresponding to the total thickness of two or more filaments as the case may be. Furthermore a solvent or adhesive must be applied between the individual filaments during winding-on in order that juxtaposed filaments of the finished cylinder will adhere together.

As previously stated, the tube can be cut along one side as it is being displaced axially over the drum. Any convenient cutting means may be provided for this purpose, for example a knife may be secured on the drum so as to project radially outwards with its cutting edge facing towards the end of the drum where the filament is being fed to the drum.

Alternatively the knife may be retractable and such an arrangement is shown in Figure 5. In Figure 5, the knife 19 is carried on the outer end of a rod 20 so as to be movable to project through an opening 21 in the drum 1, the projected position being indicated in dotted lines. The inner end of the rod 20 is pivoted to one arm of a bell-crank lever 22 the other end of which is pivoted to a push rod 23 adapted to be engaged by a pressure ring 24 which is slidable but does not rotate

with the shaft 3. Any convenient means, for example electrical, hydraulic or mechanical may be provided for moving the pressure ring to cause projection of the knife 19. The knife 19 can therefore be brought into operation as and when desired either for continuously cutting the tube, or for intermittently cutting only those convolutions which have not been caused to adhere to adjacent convolutions.

WHAT I CLAIM IS:—

1. A continuous process for the production of sheets of thermoplastic material in which a filament or band of thermoplastic material is wound on to a rotating member or former, the juxtaposed convolutions are caused to adhere to one another, and the tube so formed is progressively displaced axially relatively to the said former, the tube being finally cut axially and opened out into sheet form.

2. A process according to claim 1, in which the filament or band is caused to engage with a stop member as it is being wound on to the rotating member or former, whereby the said stop member causes the progressive axial displacement of the tube.

3. A process according to claim 2, in which the end of the filament or band is releasably secured to the rotating member or former at a position spaced apart axially from the stop member and a number of convolutions are wound on until the filament or band approaches the stop member, whereafter the subsequent convolutions are caused to adhere to one another during the winding-on operation.

4. A process according to any one of the preceding claims, in which the adhesion of juxtaposed convolutions of the filament or band is interrupted after a predetermined length of tube has been produced, whereafter a new length of tube is started without interruption of the filament or band.

5. Apparatus for carrying out the process of claim 1, comprising a short drum which is rotatably mounted and has one end free, and a stop member disposed at or adjacent to the other end of the drum, the stop member being adapted to engage with the filament or band as the latter is being wound on the drum so as to progressively displace the convolutions axially during the winding-on operation and means for axially cutting the tube formed from the adhered convolutions to form a sheet.

6. Apparatus according to claim 5, in which the stop member is stationary.

7. Apparatus according to claim 5, in which the stop member comprises a ring encircling the drum.

8. Apparatus according to claim 5, in which the stop member comprises a ring encircling the drum, part of the side of the ring facing the filament or band, preferably approximately through 180 degrees, defining a helical path.

9. Apparatus according to claim 7, in which the start of the helical portion of the ring is disposed adjacent to the position where the filament is fed to the drum during the winding-on operation.

10. Apparatus according to any one of claims 7 to 9, in which the ring is adjustable circumferentially around the drum.

11. Apparatus according to claim 5, in which the stop member comprises a freely rotatable roller mounted adjacent to the said other end of the drum and adapted to be engaged by the filament as the latter is being wound on to the drum.

12. Apparatus according to claim 11, in which the roller has a peripheral groove adapted to accommodate the filament the cross-sectional shape of the groove corresponding with the desired cross-sectional shape of the filament.

13. A process according to any one of claims 1 to 4, in which two or more filaments or bands are simultaneously fed to the drum and are wound thereon side by side, the said two or more filaments or bands being caused to adhere together as well as to juxtaposed convolutions wound on the drum.

14. A process according to claim 13, in which the two or more filaments are of different colours and/or different degrees of transparency.

15. Apparatus according to any one of claims 5 to 12, in which a cutter is carried by the drum and is adapted to cut the convolutions as the latter are displaced axially on the drum.

16. Apparatus according to claim 15, in which the cutter is retractable within the drum, means being provided for causing the cutter to project outside the drum.

17. A process according to claim 1, substantially as herein described.

18. Apparatus according to claim 5, having its parts constructed and arranged substantially as described with reference to Figures 1 and 2, or to Figures 3 and 4, or as modified by Figure 5 of the accompanying drawings.

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815,413 COMPLETE SPECIFICATION
1 SHEET

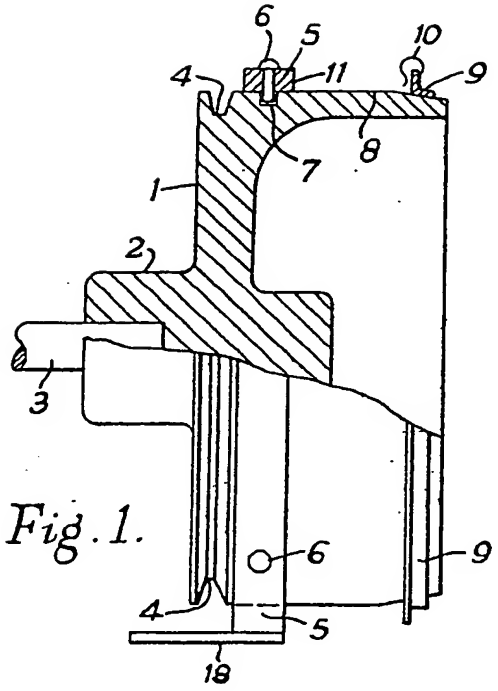

Fig. 1.

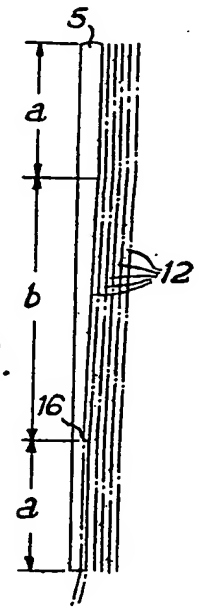

Fig. 2.

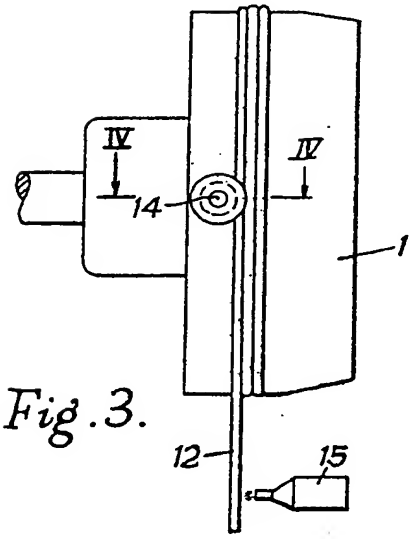

Fig. 3.

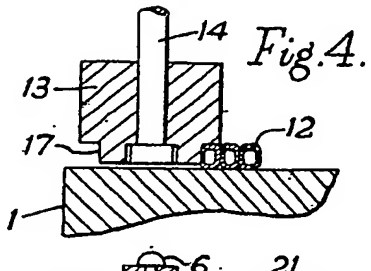

Fig. 4.

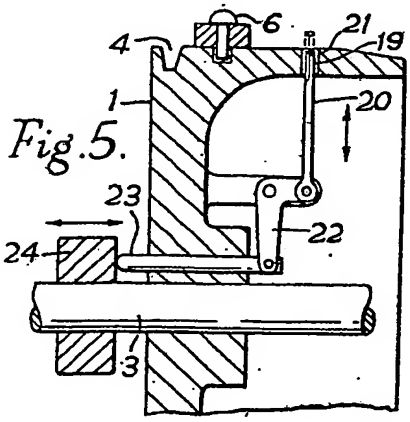

Fig. 5.